Claims:

1. An arrangement comprising:

A collection of filters responsive to a common signal, where filer i has the transfer function $V(e^{j(\omega-\frac{2\pi}{N}i)})$, V is a given low pass filter function, i=0,1,2,...N-1, and $\sum_{i=0}^{N-1}\left|V(e^{j(\omega+\frac{2\pi}{N}i)})\right|^2 = M$ for all $\omega \in (-\pi,\pi)$.

2. An arrangement comprising:

a collection of filters, each responsive to a different signal, where filer i has the transfer function $\tilde{V}(e^{j(\omega-\frac{2\pi}{N}i)})$, and V is a time-reversed version of a low pass filter V; and

a combiner for adding output signals of said filters to form an output signal of said arrangements.

3. The arrangement of claim **2** where $\sum_{i=0}^{N-1}\left|\tilde{V}(e^{j(\omega-\frac{2\pi}{N}i)})\right|^2 = N$ for all $\omega \in (-\pi,\pi)$.

4. An arrangement comprising:

an n_1 plurality of analysis filters i, where i=0,1,...n_1-1 , each developing an output signal and each coupled to a circuit that subsamples the associated output signal by a factor of K1, where each filter i has a transfer function $V_1(e^{j(\omega-\frac{2\pi}{N_1}i)})$, symmetric about $\omega = 0$, where n_1 is a first constant, N_1 is a second constant, and V_1 is a first preselected low pass filter function;

an $(N_2/2)-n_2$ plurality of analysis filters k where k= n_2+1, n_2+2,...$N_2/2$, each developing an output signal and each coupled to a circuit that subsamples the associated output signal by a factor of K2, where each filter k has a transfer

function $V_2(e^{j(\omega-\frac{2\pi}{N_2}k)})$, symmetric about $\omega=0$, where n_2 is a third constant, N_2 is a fourth constant, and V_2 is a second preselected low pass filter function; and

a transition analysis filter that develops an output signal, coupled to a circuit that subsamples said output signal of said transition filter by a factor of K1 or K2, having a bandpass transfer function that fills-in a gap frequencies that are passed by said n_1 plurality of filters and frequencies that are passed by said $(N_2/2)-n_2$ plurality of filters.

5. The arrangement of claim **4** where V_1 has an attenuation at frequencies greater than $2\pi/N_1$ that is large enough to produce an insignificant output at those frequencies, and V_2 has an attenuation at frequencies greater than $2\pi/N_2$ that is large enough to produce an insignificant output at those frequencies.

6. The arrangement of claim **4** where V_1 is such that an energy integral $\int_{\pi/N_1}^{\pi}\left|V_1(e^{j\omega})\right|^2\omega^3 d\omega$ that is associated with V_1 is lower than a preselected level.

7. The arrangement of claim **4** where $N_2<N_1$.

8. The arrangement of claim **4** where said transition analysis filter has a passband between $\frac{\pi(2n_1-1)}{N_1}$ and $\frac{\pi(2n_2+1)}{N_2}$.

9. The arrangement of claim **4** where said transition analysis filter has a transfer function $V_{1,2}(e^{j(\omega+\omega_o)})$, where $\omega_0=2\pi n_1/N_1=2\pi n_2/N_2$ and $V_{1,2}$ is a third low pass function.

10. The arrangement of claim **9** where $V_{1,2}$ is a low pass filter with a transfer function that, at positive frequencies, corresponds to said transfer function

V_2 at positive frequencies, and at negative frequencies corresponds to said transfer function V_1 at negative frequencies.

11. The arrangement of claim **9** where window shape of $V_{1,2}$ satisfies condition

$$\frac{1}{K_1}\sum_{l=0}^{n_1-1}\left|V_1(e^{J(\omega+\frac{2\pi}{N_1}l)})\right|^2+\frac{1}{K_2}\left|V_{1,2}(e^{J(\omega+\omega_0)})\right|^2+\frac{1}{K_2}\sum_{l=n_2}^{N_2-1}\left|V_2(e^{J(\omega+\frac{2\pi}{N_2}l)})\right|^2\approx R$$

when said subsampling at the circuit coupled to said transition analysis filter subsamples by a factor of K2, and the condition

$$\frac{1}{K_1}\sum_{l=0}^{n_1-1}\left|V_1(e^{J(\omega+\frac{2\pi}{N_1}l)})\right|^2+\frac{1}{K_1}\left|V_{1,2}(e^{J(\omega+\omega_0)})\right|^2+\frac{1}{K_2}\sum_{l=n_2}^{N_2-1}\left|V_2(e^{J(\omega+\frac{2\pi}{N_2}l)})\right|^2\approx R$$

when said subsampling at the circuit coupled to said transition analysis filter subsamples by a factor of K1, where $R=N_1/K_1=N_2/K_2$.

12. The arrangement of claim **9** where $V_{1,2}$ is a function such that an energy integral $E_{tr}=\int_{-\pi}^{0}\left|V_1(e^{J\omega})-V_{1,2}(e^{J\omega})\right|^2 d\omega+\int_{0}^{\pi}\left|\beta V_2(e^{J\omega})-V_{1,2}(e^{J\omega})\right|^2 d\omega$ that is associated with $V_{1,2}$ is minimized, where $\beta=\sqrt{N_1/N_2}$.

13. The arrangement of claim **4** where said transition analysis filter has a transfer function $V_{1,2}(e^{J(\omega+\omega_o)})$, where $2\pi(n_1-1)/N_1<\omega_0<2\pi(n_2+1)/N_2$ and $V_{1,2}$ is a third low pass function.

14. The arrangement of claim **13** where $V_{1,2}$ is a low pass filter with a transfer function that, at positive frequencies, corresponds to said transfer function V_2 at positive frequencies, and at negative frequencies corresponds to said transfer function V_1 at negative frequencies.

15. The arrangement of claim **13** where window shape of $V_{1,2}$ satisfies condition

$$\frac{1}{K_1}\sum_{i=0}^{n_1-1}\left|V_1(e^{j(\omega+\frac{2\pi}{N_1}i)})\right|^2+\frac{1}{K_2}\left|V_{1,2}(e^{j(\omega+\omega_0)})\right|^2+\frac{1}{K_2}\sum_{i=n_2}^{N_2-1}\left|V_2(e^{j(\omega+\frac{2\pi}{N_2}i)})\right|^2\approx R$$

when said subsampling at the circuit coupled to said transition analysis filter subsamples by a factor of K2, and the condition

$$\frac{1}{K_1}\sum_{i=0}^{n_1-1}\left|V_1(e^{j(\omega+\frac{2\pi}{N_1}i)})\right|^2+\frac{1}{K_1}\left|V_{1,2}(e^{j(\omega+\omega_0)})\right|^2+\frac{1}{K_2}\sum_{i=n_2}^{N_2-1}\left|V_2(e^{j(\omega+\frac{2\pi}{N_2}i)})\right|^2\approx R$$

when said subsampling at the circuit coupled to said transition analysis filter subsamples by a factor of K1, where $R=N_1/K_1=N_2/K_2$.

16. An arrangement comprising:

an n_1 plurality of upsampling circuits, each responsive to an associated input signal and upsampling its input signal by a factor of K1;

an n_1 plurality of synthesis filters i where i=0,1,...n_1-1 , each responsive to an associated one of said n_1 plurality of upsampling circuits, where each filter i has a transfer function $V_1(e^{j(\omega+\frac{2\pi}{N_1}i)})$, symmetric about $\omega=0$, n_1 is a first constant, N_1 is a second constant, and V_1 is a first preselected low pass filter function ;

an $(N_2/2)-n_2$ plurality of upsampling circuits, each responsive to an associated input signal port and upsampling its input signal by a factor of K2;

an $(N_2/2)-n_2$ plurality of synthesis filters k where k= n_2+1, n_2+2,...$N_2/2$, each responsive to an associated one of said $(N_2/2)-n_2$ plurality of upsampling circuits, where each filter k has a transfer function $V_2(e^{j(\omega+\frac{2\pi}{N_2}k)})$, symmetric about $\omega=0$, n_2 is a third constant, N_2 is a fourth constant, and V_2 is a second preselected low pass filter function;

a transition upsampling circuit, responsive to an associated input signal port that oversamples its input signal by a factor of K1 or K2;

a transition synthesis filter responsive to said transition upsampling circuit, having a bandpass transfer function that fills-in a gap frequencies passed by said n_1 plurality of filters and frequencies passed by said $(N_2/2)-n_2$ plurality of filters; and

an addition circuit that combines output signals of said n_1 plurality of filters, said transition filter, and said $(N_2/2)-n_2$ plurality of filters, to develop an output signal.

17. The arrangement of claim **16** where V_1 has an attenuation at frequencies greater than $2\pi/N_1$ that is large enough to produce an insignificant output at those frequencies, and V_2 has an attenuation at frequencies greater than $2\pi/N_2$ that is large enough to produce an insignificant output at those frequencies.

18. The arrangement of claim **16** where V_1 is such that an energy integral $\int_{\pi/N_1}^{\pi}\left|\tilde{V}_1(e^{j\omega})\right|^2 \omega^3 d\omega$ that is associated with V_1 is lower than a preselected level.

19. The arrangement of claim **16** where $N_2<N_1$.

20. The arrangement of claim **16** where said transition synthesis filter has a pass band between $\frac{\pi(2n_1-1)}{N_1}$ and $\frac{\pi(2n_2+1)}{N_2}$.

21. The arrangement of claim **16** where said transition synthesis filter has a transfer function $\tilde{V}_{1,2}(e^{j(\omega+\omega_o)})$, where $\omega_0=2\pi n_1/N_1=2\pi n_2/N_2$ and $\tilde{V}_{1,2}$ is a third low pass function.

22. The arrangement of claim **16** where said transition synthesis filter has a transfer function $\tilde{V}_{1,2}(e^{j(\omega+\omega_0)})$, where $2\pi(n_1-1)/N_1<\omega_0<2\pi(n_2+1)/N_2$ and $\tilde{V}_{1,2}$ is a third low pass function.

23. The arrangement of claim **21** where $\tilde{V}_{1,2}$ is a function such that an energy integral $E_{tr}=\int_{-\pi}^{0}\left|\tilde{V}_1(e^{j\omega})-\tilde{V}_{1,2}(e^{j\omega})\right|^2 d\omega+\int_{0}^{\pi}\left|\beta\tilde{V}_2(e^{j\omega})-\tilde{V}_{1,2}(e^{j\omega})\right|^2 d\omega$ that is associated with $\tilde{V}_{1,2}$ is minimized, where $\beta=\sqrt{N_1/N_2}$.

24. The arrangement of claim **21** where $\tilde{V}_{1,2}$ is a low pass filter with a transfer function that, at positive frequencies, corresponds to said transfer function V_2 at positive frequencies, and at negative frequencies corresponds to said transfer function V_1 at negative frequencies.

25. The arrangement of claim **21** where window shape of $\tilde{V}_{1,2}$ satisfies condition

$$\frac{1}{K_1}\sum_{l=0}^{n_1-1}\left|\tilde{V}_1(e^{j(\omega+\frac{2\pi}{N_1}l)})\right|^2+\frac{1}{K_2}\left|\tilde{V}_{1,2}(e^{j(\omega+\omega_0)})\right|^2+\frac{1}{K_2}\sum_{l=n_2}^{N_2-1}\left|\tilde{V}_2(e^{j(\omega+\frac{2\pi}{N_2}l)})\right|^2\approx R$$ when said

subsampling at the circuit coupled to said transition synthesis filter subsamples by a factor of K2, and the condition

$$\frac{1}{K_1}\sum_{l=0}^{n_1-1}\left|V_1(e^{j(\omega+\frac{2\pi}{N_1}l)})\right|^2+\frac{1}{K_1}\left|V_{1,2}(e^{j(\omega+\omega_0)})\right|^2+\frac{1}{K_2}\sum_{l=n_2}^{N_2-1}\left|V_2(e^{j(\omega+\frac{2\pi}{N_2}l)})\right|^2\approx R$$

when said subsampling at the circuit coupled to said transition analysis filter subsamples by a factor of K1, where $R=N_1/K_1=N_2/K_2$.

26. The arrangement of claim **4** comprising:

a signal processing stage responsive to output signals of said n_1 plurality of analysis filters, said $(N_2/2)-n_2$ plurality of analysis filters, and said transition analysis filter, and developing therefrom a plurality of processed signals; and

an arrangement according to claim **16** responsive to said plurality of processed signals.

27. The arrangement of claim **26** where said plurality of processed signals comprises n_1 processed signals that are respectively derived from output signals of said n_1 plurality of analysis filters, a processed signal that is derived from said transition analysis filter, and $(N_2/2)-n_2$ processed signals that are respectively derived from said $(N_2/2)-n_2$ plurality of analysis filters.

28. The arrangement of claim **27** where

a processed signal derived from filter i of said n_1 plurality of analysis filters is coupled to the upsampling circuit that is coupled to filter i of said n_1 plurality of synthesis filters;

a processed signal derived from filter k of said $(N_2/2)-n_2$ plurality of analysis filters is coupled to the upsampling circuit that is coupled to filter k of said $(N_2/2)-n_2$ plurality of synthesis filters; and

said processed signal derived from said transition analysis filter is coupled to the upsampling circuit that is coupled to said transition synthesis filter.

29. The arrangement of claim **28** where V_q is a low pass filter, q takes on the value 1, 2, or 1,2, and V_q a time-reversed version of said filter V_q.

30. A filter arrangement comprising:

P filter banks, each of which covers a distinct, non-overlapping, frequency band, leaving a frequency gap between a frequency where a pass band of one of said P filter banks ends and a pass band of any another one of said P filter banks begins, thus forming *P*-1 frequency gaps, and where each filter bank includes a

plurality of filters with filter transfer functions that are complex modulation modulates of a filter transfer function that is given for said filter bank; and

P-1 transition filters, each being a passband filter that fills one of said frequency gaps.

31. The arrangement of claim **30** where each of said transition filters has a transfer function that is related to the transfer function of filters in filter banks that are adjacent to said transition filter.

32. The arrangement of claim **30** where said given filter transfer function of a filter bank that covers a given frequency band is wider in frequency than said given filter transfer function of a filter bank that covers a lower frequency band.